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# THE LOCAL SUPERGALAXY AS THE STRUCTURED ASPECT OF A UNIVERSAL BACKGROUND OF X-RAYS

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#### **ABSTRACT**

It is shown that Silk's model for a universal X-ray background leads to a measurable structure arising from the local supergalaxy. A telescope tuned for detecting this structure would have a field of view  $\gtrsim 1$  arc degree with a resolution  $\lesssim 10$  arc minutes. The ratio of the expected signal to the observed diffuse background is of the order of unity.

### THE LOCAL SUPERGALAXY AS THE STRUCTURED ASPECT OF A UNIVERSAL BACKGROUND OF X-RAYS

An important application for an X-ray telescope (1,2) with a resolution of ≤10 arc minutes is the measurement of the fine structure characteristic of a universal background. Silk (3) attributes the observed background to the superposed contributions from all normal galaxies. The following discussion describes how this model leads to a measurable structure.

#### Definitions:

I = observed diffuse background flux (ergs/cm<sup>2</sup>-sec-sr)

 $\phi = \text{half-angle subtended by an average galaxy}$ 

 $\alpha$  = half-angle for the average field of view required to observe one galaxy

r = average galactic radius

q = X-ray power output for an average galaxy (ergs/sec)

For the situation where the observed background is the superposition of the contributions from all galaxies, it is expected that

$$I(\pi\alpha^2) = \frac{q\phi^2}{4\pi r^2}.$$
 (1)

The observed  $^{(4,5)}$  X-ray background flux is

$$I = 9 \times 10^{-8} \text{ ergs/cm}^2 \text{-sec-sr}$$
 (2)

Silk<sup>(3)</sup> estimates that the X-ray power output from our own galaxy is

$$q \simeq 10^{39} \text{ ergs/sec}$$
 . (3)

Insertion of I and q, as given by (2) and (3), into Equation (1) yields

$$\frac{\phi}{\alpha} = 6 \times 10^{-23} \,\mathrm{r} \quad . \tag{4}$$

For r  $\sim$  3 x  $10^{22}$  cm., this Equation (4) indicates that  $\phi$  and  $\alpha$  are of the same order. Hence, for the  $\sim 10^{10}$  galaxies of the metagalaxy  $^{(6,7)}$ 

$$\pi\phi^2 \simeq \pi\alpha^2 = 4\pi/10^{10}$$
  $\rightarrow \phi \simeq 4 \text{ arc seconds}$  . (5)

This angular size ( $\phi \simeq 4$  arc seconds) for an object of radius equal to that of our galaxy ( $r \sim 3 \times 10^{22}$  cm) would correspond to a distance of  $\sim 2 \times 10^{27}$  cm., comparable to the radius (R) of the metagalaxy. The fineness of this structure ( $\phi \simeq 4$  arc seconds) would be difficult to detect.

The situation for the local supergalaxy<sup>(7)</sup> of  $\sim 10^4$  galaxies is promising as regards detectable structure. The radius (R') of the local supergalaxy is R' $\sim 2 \times 10^{25}$  cm. Therefore, the half-angle  $\phi'$  subtended by a representative galaxy would be

$$\phi' = \frac{r}{R'}$$

$$\rightarrow \phi' \simeq 5$$
 arc minutes . (6)

The half-angle ( $\alpha'$ ) for the average field of view required to observe one such galaxy is given by

$$\pi(\alpha')^2 = 4\pi/10^4$$

$$\rightarrow \alpha' \simeq 1 \text{ degree} . \tag{7}$$

Over a field of view for which  $\alpha' \sim 1$  degree, it is expected that the average background (2) is achieved, corresponding to  $\sim 9 \times 10^{-8} \, \mathrm{ergs/cm^2-sec-sr.}$  However, over the  $\sim 5$  arc minutes half-angle subtended by a representitive galaxy of the local supergalaxy it is expected that the background increases by an amount

$$\Delta I \simeq \frac{q}{(2\pi r)^2} = 3 \times 10^{-8} \, \text{ergs/cm}^2 - \text{sec-sr} , \qquad (8)$$

for  $q = 10^{39}$  ergs/sec and  $r \approx 3 \times 10^{22}$  cm.

by

Comparing (8) with (2), it is important to note that  $\triangle I$  is comparable to I. The flux (J) from a representative galaxy of the local supergalaxy is given

$$J = (\triangle I) (\pi \phi'^{2})$$

$$\rightarrow J \simeq 2 \times 10^{-13} \, \text{ergs/cm}^{2} \text{-sec.}$$
 (9)

For a spectrum of the form given by Seward et al. (4) for photons  $\gtrsim 4$  keV, this energy flux (9) corresponds to  $\sim 2 \times 10^{-5}$  photons/cm<sup>2</sup>-sec.

In summary, the galaxies of the local supergalaxy are expected to give a significant structure to the X-ray background, with the following features:

- i) The deviation in the flux is comparable to the general sky background.
- ii) The enhanced flux is associated with angular regions  $\sim 5$  arc minutes, half-angle.
- iii) The average field of view required to observe one such enhanced region is ~1 degree half-angle.
- iv) The photon flux ( $\gtrsim 4$  keV) anticipated from a representative galaxy of the local supergalaxy is  $\sim 2 \times 10^{-5}$  photons/cm<sup>2</sup>-sec.

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